UNIVERSITÉ DE SHERBROOKE

Faculté d'éducation

Le rôle de la fréquence de la rétroaction verbale dans l'acquisition et la rétention des compétences en instrumentation en hygiène dentaire

The role of verbal feedback frequency in the acquisition and retention of fine motor instrumentation skills in dental hygiene

par

Deborah DesRivieres

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Abstract

The purpose of this research was to determine the optimal verbal feedback frequency following six practice probing trials in promoting fine motor skills acquisition and retention in novice dental hygiene students. In this quasi-experimental design, 26 second year dental hygiene students enrolled in a preclinical instrumentation course were randomly divided into two groups. The control group was given verbal feedback following each of the six practice probing trials (100% feedback frequency). The experimental was afforded feedback during trials 1, 3 and 5 of the six trials (50% feedback frequency). Participants learned to probe a peer's maxillary first premolar tooth in a preclinical setting. In this study participants were subjected to a pre-test and post-test to evaluate probing skills following the six practice trials and a retentive test conducted one week later. A t-test was used to compare probing mean scores on the practical skills tests between the control and experimental groups. Student attitudes and perceptions regarding the verbal feedback they received was assessed using a five-point Likert scale and four open ended questions from an anonymous online survey. The mean performance scores for the students in the control and experimental group demonstrated no statistically significant difference on the pre, post and retentive tests. Subjective comments from the online survey revealed 73.1% of participants felt confident, post trials, in their ability to effectively self-assess their probing performance in the absence of instructor feedback. The results could not conclusively ascertain which verbal feedback (100% or 50%) was superior however they did demonstrate improved probing performance scores on the post tests. Limiting the number of practice trials to six seemed to have a positive impact on novice dental hygiene students learning of fine motor skills because it did not overwhelm the learner with too much information.

Key words: verbal feedback, frequency, dental hygiene, fine motor learning, probe

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List of Abbreviations

ID: Independent variable

DV: Dependent variable

JAC: John Abbott College

KP: Knowledge of performance

KR: Knowledge of results

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Résumé

Le but de cette recherche était de déterminer la fréquence de rétroaction verbale optimale à la suite de six essais cliniques visant à promouvoir l'acquisition et la rétention de la motricité fine chez des étudiants novices en hygiène dentaire. Lors de cette étude quasi expérimentale, 26 étudiants de deuxième année en hygiène dentaire, inscrits à un cours d'instrumentation préclinique, ont été divisés au hasard en deux groupes. Le groupe témoin a reçu une rétroaction verbale après chacun des six essais de sondage pratique, soit une fréquence de rétroaction de 100 %. Le groupe expérimental quant à lui, a bénéficié d'une rétroaction à une fréquence de 50 %, soit au cours des essais 1, 3 et 5 sur les 6 essais. Les participants ont appris à sonder la première prémolaire du maxillaire supérieur, d'un pair, dans un contexte préclinique. Durant cette étude, les participants ont été soumis à un pré-test et à un post-test, pour évaluer les compétences de sondage après les six essais pratiques, et ils ont été soumis à un test de rétention, effectué une semaine plus tard. Un test-T a été utilisé pour comparer les scores moyens de sondage, sur les tests de compétences pratiques entre les groupes témoins et expérimentaux. Les attitudes et les perceptions des élèves vis-à-vis les commentaires verbaux qu'ils ont reçus ont été évaluées à l'aide d'une échelle en cinq points de Likert et de quatre questions ouvertes, provenant d'un sondage anonyme en ligne. Les scores de performance moyens, pour les étudiants du groupe témoin et du groupe expérimental, n'ont pas montré de différence statistiquement significative entre les tests pré, post et rétentifs. Les commentaires subjectifs de l'enquête en ligne, ont révélé que 73,1% des participants étaient convaincus, après les essais, de leur capacité à auto-évaluer efficacement leur performance de sondage en l'absence de rétroaction des instructeurs. Les résultats n'ont pas permis de déterminer de façon concluante quelle rétroaction verbale (100% ou 50%) était supérieure, mais ils ont toutefois démontré des scores de performance, au sondage, améliorés sur les post-tests. Également,

limiter le nombre d'essais pratiques à six, semblait avoir un impact positif sur l'apprentissage de la motricité fine, chez les étudiants novices en hygiène dentaire, car cela ne surchargeait pas l'apprenant avec trop d'informations.

Mots-clés: rétroaction verbale, fréquence, hygiène dentaire, apprentissage moteur fin, sonde

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Introduction

In Canada, dental hygienists are licensed oral health care professionals registered within a regulatory body. They are required to determine health risk factors that may complicate dental treatment, assess their patient's oral condition, establish evidence-based care, and perform instrumentation skills to treat a patient's oral periodontium.

According to the Canadian Dental Association seven out of ten people will develop periodontal disease within their lifetime. Periodontal disease is a gingival (gum) infection that oral health care givers must examine in order to effectively treat their patients. Failure to do so may lead to loss of bone and tissue attachment. Being primarily asymptomatic most patients are unaware that they have this disease. A periodontal probe is an assessment instrument implemented in dentistry to measure periodontal disease.

Teaching fine motor skills such as probing to novice dental hygiene students in a preclinical dental hygiene course is fundamental to their ability to provide optimal care to future patients. It is imperative dental hygiene educators provide a learning environment that promotes observational skills related to the practical task, encourage decision-making and support transfer of knowledge from didactic to the preclinical setting. Basic to fine motor learning in dental hygiene is student understanding of instrumentation criteria. In class, they actively construct their knowledge of probing while practicing fine motor skills on a typodont (a replica of the oral cavity that includes teeth, gingiva and a palate). As they learn and perfect the desired skill they must scrutinize their performance and modify their actions during subsequent attempts to achieve desired outcome (instrumentation criteria).

Dental hygiene students struggle to trust their ability to self-assess practical skills based on the theoretical concepts discussed in the classroom setting. They resist modifying

performance based on their observational and sensory cues and rely solely on verbal feedback from their instructors. This lack of confidence in their ability to assess their actions renders students unable to retain their instrumentation skills in subsequent practice sessions. It is therefore fundamental to determine which verbal feedback frequency (50% or 100%) is more conducive to learning instrumentation skills in the dental hygiene practical setting. In dental hygiene the goal of verbal feedback in practical skills' acquisition is to guide the learner to assess their instrumentation performance and improve the desired skill. When successful this technique should allow the student to modify errors as needed in the absence of verbal feedback.

During this study second year dental hygiene students learned to probe a peer's maxillary first premolar tooth during six practice trials. The control group received 100% verbal feedback following each of the six practice trials and the experimental group received 50% verbal feedback following practice trials 1, 3 and 5; no feedback was provided following trials 2, 4 and 6. The verbal feedback was tailored to the students' needs once they had probed the maxillary first premolar. Timely precise verbal feedback is essential to enhance student understanding of probing errors so as to guide them towards making adjustments during subsequent instrumentation attempts. A rater was assigned to evaluate the same student for all three probing tests. The data was analyzed to determine if mastering fine motor skills in dental hygiene requires frequent verbal feedback due to the complexity of the desired task or, if instructors should reduce the amount of verbal feedback to encourage students to self-assessment through problem solving, enabling students to modify their actions in the absence of feedback.

This study examined the literature regarding the stages, acquisition and retention of motor learning, experiential learning, the role of augmented feedback and the effects of the guidance hypothesis on motor learning.

The quasi-experimental design analyzed quantitative and qualitative data to determine which verbal feedback frequency (50% or 100%), if any, is more beneficial when learning probing skills.

Chapter 1: Problem Statement

A significant amount of research has been devoted to the variables that guide the acquisition and retention of motor skills (Winstein & Schmidt, 1990). Although imperative for students in dental hygiene education to effectively learn and improve instrumentation skills, there has been little empirical research addressing which teaching methods are most effective. Dental hygiene students are required to perfect eye-hand coordination in order to implement the specialized, precise, incremental steps necessary for instrumentation skills.

Augmented feedback provides the learner information as to their progress so they can implement the necessary changes conducive to the task (Walsh, Ling, Wang and Carnahan, 2009 and Winstein & Schmidt, 1990). It has been widely researched as an effective teaching strategy and has traditionally been provided to John Abbott College (JAC) dental hygiene students when learning fine motor skills (Adams, 1971; Boyce, 1991; Magill, 1993; Sattelmayer, Elsig, Hilfiker & Baer, 2016; Sharma, Chevidikunnan, Khan & Gaowgzeh, 2016; Weeks and Kordus, 1998; Winstein, Pohl & Lewthwaite,1994 and Winstein & Schmidt, 1990).

According to the literature, augmented feedback type is classified as knowledge of results (KR) and/or knowledge of performance (KP). Knowledge of results (KR) is defined as information related to the outcome of the performance (Salmoni, Schmidt, Walter, 1984 and Weeks & Kordus, 1998) whereas knowledge of performance (KP) is described as information related to the characteristics of the movement (Mononen, Viitasalo, Konttinen & Era, 2003 and Schmidt & Wrisberg, 2004). Students in dental hygiene receive feedback in response to the characteristics of their hand (grasp) and arm movement as they perform fine motor skills (KP).

There are two well-researched variables in the literature of motor learning related to augmented feedback; timing and frequency (Mononen et al., 2003). Feedback timing can be

provided concurrently as learners perform the task whereas terminal feedback is given at the end of the activity. Frequency refers to how many times the learner receives information following the practical trials.

In previous years at JAC, frequent verbal (KP) feedback was provided to novice dental hygiene students based on instructor availability and student needs as they learned instrumentation skills within a four-hour lab session. Over the past several years instructors had observed that students struggle to retain instrumentation skills in subsequent labs most likely due to information overload. The Guidance Hypothesis predicts that frequent feedback may have detrimental effects on motor learning because the learner comes to depend on the external source of information to perform the task (Schmidt, 1991).

Observational skills are fundamental in dental hygiene in order for the learner to assess instrumentation movements and modify them according to the desired skill. It is incumbent upon faculty to reinforce and encourage students to perfect this aptitude during their learning journey. Novice dental hygiene students struggle to effectively self-assess their instrumentation skills and therefore require immediate and precise feedback in the early stages of motor learning (Hauser and Bowen, 2009).

In this study, terminal feedback was provided to novice learners because it encouraged them to focus on intrinsic sensory feedback and visual cues as they performed slow-moving highly precise instrumentation skills.

I hypothesized that when instructors provide frequent feedback novice dental hygiene learners experience information overload. Hauser and Bowen (2009) highlighted that continuous feedback using a virtual reality system overwhelmed the novice learner and led them to become dependent on the information in order to improve their performance (as cited in Wierinck,

Puttmans & van Steenbergheet, 2005). Frequent concurrent feedback may hinder the ability of novice dental hygiene learners to implement observational abilities, hone in on intrinsic sensory feedback and self-correct as they perform the desired instrumentation skill. They are unable to judge their performance accurately because of consistent feedback provided by the experts as they perform the skill. Educators must provide opportunities for students to learn self-assessment strategies in order to enhance motor performance (Hauser and Bowen, 2009). Verbal feedback is beneficial to learners when used to reduce errors; however detrimental to retention skills when relied upon (Hauser and Bowen, 2009; Walsh, Ling, Wang & Carnahan, 2009 and Winstein et al., 1994).

Most studies in the literature examined knowledge of results timing and frequency when performing simple "single degree of freedom movement" (Mononen et al., 2003, p. 867). In dental hygiene perfecting instrumentation skills requires the learner to implement slow and methodical movements to achieve success. Dental hygiene instructors at JAC provide knowledge of performance (KP) verbal feedback regarding the student's hand and arm movement pattern when attempting to learn instrumentation skills. The role of verbal feedback is to guide and motivate the leaner to attain mastery of the desired motor skill and repeat the performance in subsequent sessions. As little information is available regarding the acquisition and retention of motor skills in dentistry, this study will contribute to the literature.

The purpose of this research was to determine the optimal frequency (50% or 100%) of KP verbal feedback at the end of the instrumentation skill in promoting fine motor instrumentation skills acquisition and retention in novice dental hygiene students.

Chapter 2: Conceptual Framework

In Canada, dental hygienists are licensed professionals registered with the regulatory body in their province of practice. They are oral health care providers who may work independently, practice in partnership with dentists and frequently consult with other health care givers. The primary function of a dental hygienist is to assess the overall health of their patients, determine health risk factors that may complicate dental treatment, establish evidence-based care, and perform highly skilled fine motor instrumentation skills to treat a patient's oral condition.

At JAC, fine motor instrumentation skills are taught to second year dental hygiene students to enable them to develop the eye-hand coordination necessary to effectively manipulate specialized instruments required to assess a patient's oral health and provide individualized treatment. The ability to effectively learn these skills is imperative in the discipline of Dental Hygiene.

Periodontal disease is a gum infection that over time may lead to a of loss of bone and tissue attachment. A periodontal probe is an assessment instrument utilized in dentistry to evaluate periodontal disease. It is fundamental that novice dental hygiene students develop the precise probing skills necessary to accurately assess a patient's periodontal condition in order to provide optimal quality care.

A key issue when addressing the learning process is the transfer of theoretical concepts to the preclinical setting. In class, as the learner applies principles of probing techniques on a typodont (a model of the oral cavity), they actively construct their knowledge while practicing fine motor skills. As an educator, it is my role to create a learning environment that promotes observational skills, decision-making and transfer of knowledge from didactic to the preclinical

setting. Students initially are brought to a point of disequilibrium through problem solving as they learn instrumentation skills. They are then encouraged to grapple with their understanding of theoretical knowledge in order to apply it in a preclinical setting. They initially resist this form of learning, however in time come to appreciate that their efforts render them more knowledgeable and confident in their educational outcomes.

Constructivist learning theory is based on learners' active participation in grasping or comprehending the context and applying the skills to accomplish the learning activity. At JAC, a social constructivism approach to teaching and learning permeates the classroom setting as dental hygiene students enhance their knowledge of fine motor instrumentation skills through peer and teacher feedback. Students reflect and collaborate to come to new understandings regarding probing (instrumentation) concepts while practicing on their typodonts. They learn that in order to achieve their goals, they must be co-participants in their educational outcomes. Students and teachers learn from each other and collectively knowledge acquisition is enhanced on a deeper level. Students acquire an appreciation for learning that is forever evolving and participation by all members fosters successful learning outcomes within the caring, inclusive and safe classroom/preclinical setting.

In a preclinical setting, second year dental hygiene students practice their probing skills on a peer using a Williams probe (Hu-Friedy-PW6). They apply the established principles of probing; modified pen grasp, adaptation, angulation and walking stroke in order to effectively assess a peer's periodontium. Learning in a real-world context (working on a peer rather than a post phantom head/manikin) reinforces experiential learning and is based on Jean Piaget theory of constructivism.

The experiential model reinforces the notion that learning is an active process and develops as the novice student reflects on their experience (Jorge, 2014). Fundamental to skill acquisition is the ability for students to hone in on their intrinsic sensory feedback and observational skills. The challenge for the dental hygiene instructor is to gage when and how much verbal feedback is beneficial to enhance the learners' ability to recognize intrinsic sensory cues and promote reflective practice when performing fine motor tasks.

Over the past several years, I observed that students were unable to retain their instrumentation skills in subsequent practical sessions. My observations seem to be supported by the guidance hypothesis that states that in the absence of external feedback, the learner's performance during the retention phase is limited owing to their reliance upon verbal feedback during the acquisition phase of motor learning. (Anderson, Magill, Sekiya and Ryan, 2005; Park, Shea & Wright, 2000 and Winstein et al., 1994).

As students learn implementation of a new instrument they are often apprehensive and rely on the instructor to provide verbal feedback as they learn how to work with it. Hauser and Bowen (2009) referred to this stage of motor learning as "rule driven and dependent on feedback" (p. 392). Many novice students do not trust their own observational skills and expect their instructor to assess their performance. The guidance hypothesis supports the importance of reducing verbal feedback for novice learners encouraging them to rely on observational cues and intrinsic feedback to enhance their capacity to assess their progress and continue to implement self-directed learning within their professional lives. This strategy supported Hauser and Bowen's (2009) opinion that self-assessing one's skills during motor learning is fundamental to improve performance outcomes. It was therefore important to determine which verbal feedback frequency (50% or 100%) is more conducive for learning instrumentation skills in the dental

hygiene practical setting. The goal of verbal feedback is to guide the students, encourage them to assess their instrumentation performance and initiate necessary modifications expeditiously.

It is my belief that central to the development of a sound practical skill, is the student's ability to utilize their cognitive processes when assessing their actions. This proficiency should ensure best practice in future preclinical sessions. Students must apply theoretical concepts of instrumentation as they analyze their performance based on intrinsic sensory feedback and visual cues. To support these skills during the cognitive phase of motor learning, novice dental hygiene students received verbal feedback once they finished probing the circumference of the assigned tooth. Instructors must provide opportunities for learners to grapple with their performance in order to promote better self-assessment skills. Delaying feedback should encourage students to evoke self-awareness by means of internal sensory feedback as they employ visual cues while probing a tooth.

In dental hygiene novice learners are encouraged to assess their hand movement, grasp force (intrinsic sensory feedback), probe tip angulation and walking stroke distance in order to accomplish the expected outcome. The opportunity to reflect during the cognitive phase is critical to ensure performance success when they learn fine motor skills. I believe that novice dental hygiene students who exhibit poor instrumentation performance during the retention phase failed to assess their errors and modify them during the acquisition/cognitive phase of learning.

The independent variables of this study are: terminal (KP) verbal feedback following each of the six practice probing trials; 100% feedback frequency (IV-1) and terminal (KP) verbal feedback following trials 1, 3 and 5; with no feedback following trials 2, 4 and 6; 50% feedback frequency (IV-2).

The dependent variables: to improve instrumentation probing skills scores following the six practices trials on a post-test (DV-1) and retention test when re-examined one week later (DV-2).

2.1 Hypotheses

Ho: There is no difference in mean probing scores between the control group (100% KP verbal feedback frequency) and the experimental group (50% KP verbal feedback frequency) following the six practice trials on a post-test and when re-examined one week later on a retentive test.

H_1: The most effective verbal teaching method to enhance probing mean scores on a post-test is 100% KP verbal feedback frequency (IV-1).

H_2: The most effective verbal teaching method to enhance probing mean scores on a retentive test is 50% KP verbal feedback frequency (IV-2).

2.2 Theories of Learning

There are many theories to explain how learners acquire motor skills (Adams, 1971; Fitts and Posner, 1967, and Schmidt, 1975). This study examined their similarities and difference and relate them to the field of dental hygiene fine motor learning.

Experiential learning is a model developed by Kolb (1976) whereby the learner actively engages in an experience (Jorge, 2014). This model draws from a constructivism approach to teaching. Hands-on learning is critical for dental hygiene students as they learn precise fine motor skills. At JAC, dental hygiene instructors analyze students' instrumentation skills and provide verbal feedback based on the performance. During the cognitive (early) phase of motor learning novice dental hygiene students come to rely on instructor verbal feedback, due to a lack of self-confidence with their observational abilities and intrinsic sensory feedback.

Feedback is a valued learning strategy during the acquisition/cognitive phase of motor learning (Winstein et al., 1994 and Winstein & Schmidt, 1990). The literature identified the downfall of augmented feedback to when students learn to rely on an external source of guidance and neglect to self-assess their performance. The guidance hypothesis predicts that augmented feedback is beneficial during the early phase of motor learning because it reduces errors however it is detrimental during the retention phase when feedback is withdrawn, and the learner is unable to evaluate and modify their performance (Winstein, et al., 1994). The ability to impart instruction without overwhelming the learner is crucial in dental hygiene to prevent reliance in future performances.

2.3 Research Questions

1. Which KP verbal feedback frequency (50% or 100%) is most effective in enhancing probing performance scores immediately following six probing trials (post-test)?
2. Which KP verbal feedback frequency (50% or 100%) is most effective in enhancing probing performance scores one-week post probing trials (retentive test)?

There is a lack of literature in dentistry examining variables that impact fine motor learning. The purpose of this research was to determine the optimal KP verbal feedback frequency (50% or 100%) following six practice probing trials in promoting fine motor skills acquisition and retention in novice dental hygiene students.

Chapter 3: Literature Review

Learning can be defined as any change in behavior or an individual's capacity to perform a skill with competence as a result of practice or experience (Sharma et al., 2016). The authors state that motor learning requires the learner to actively think about their actions and focus on intrinsic sensory feedback in order to perform the skill accurately.

Fundamental to fine motor skills acquisition and retention in dental hygiene are various critical stages. They include observation of the desired skill, execution, augmented feedback, and practice (Sharma et al., 2016).

3.1 Stages of Motor Learning

Fitts (1964) and Fitts and Posner (1967) proposed that developing motor skills involves cognitive, associative and autonomous phases to learning. Motor skill learning begins when the learner receives declarative information about the skill. The cognitive phase requires the learner to think about what is required to perform the motor task (Schmidt & Lee, 2005). The learner forms a motor program that is an "abstract representation of the movement that centrally organizes and controls the many degrees of freedom in performing the action" (Schmidt & Lee, 2005, p. 182). In this stage, novice dental hygiene students process information related to the skill to cognitively understand the probing criteria and parameters of the desired movement. Guiding the learner with verbal feedback and providing time for them to practice the skill are extremely effective teaching strategies during the cognitive stage (Schmidt & Lee, 2005).

When novice dental hygiene students learn a new instrument, they focus on each step in a conscious manner in order to perfect the motor skill. In dental hygiene, fine motor learning is frequently slow, the learner's decisions being indecisive and often inefficient (Hauser and Bowen, 2009). This stage of learning has long been of interest to researchers as feedback plays a

critical role in improving performance outcomes (Winstein, Pohl & Lewthwaite,1994 and Winstein and Schmidt, 1990). The learner must grapple with performance errors and modify their skills to achieve the desired outcome (Fitts and Posner, 1979).

With continued practice the learner progresses to the associative phase where they process their movements and develop strategies for improvement and modification when needed (Fitts and Posner, 1967 and Adams, 1971).

The autonomous phase occurs after repeated practice sessions often taking years for the learner to become proficient at the skill (Fitts and Posner, 1967). As dental hygiene students' progress throughout their preclinical stage, their movements slowly become automatic and their cognitive process only requires a semi-conscious effort to perform the task (Hauser and Bowen, 2009).

In 1971, Adams expanded on Fitts and Posner 's (1967) theory and introduced the closed loop theory of motor learning. Motor skill acquisition is not simply behavior driven by neuromotor programs in response to a stimulus, it involves cognitive processes, development and implementation of strategies to complete the skill (Adam's, 1971 and Fitts & Posner, 1967). Adams (1971) postulated that the learner possesses a motor program which consists of a memory trace and perceptual trace. The motor program is an abstract representation of the movement that allows the learner to perform the skill. Signals communicated through the efferent and afferent pathways allow the central nervous system to foresee, plan and guide the learner's movement (Adams, 1971). The memory trace initiates the initial motor movement plan and it is reinforced through feedback and practice. The perceptual trace compares the learner's actions to the desired movement. The learner modifies their performance based on the perceptual trace. A key element

of the Adam's theory is the way the learner responds to the perceptual trace to detect errors in order to modify their performance (Adams, 1971).

Schmidt (1975) challenges Adams' theory of learning complex and discrete fast paced motor skills. He stated the learner would require a vast amount of storage capacity in the central nervous system to amass the infinite amount of motor programs required to perform motor skills. Schmidt proposes learners develop a motor schema (generalized program) that can be adapted to various motor skills. He contended motor schemas allow for more variability particularly when learning fast paced (discrete) motor skills.

In dental hygiene, slower movements are essential to learning precise incremental instrumentation steps. Once the learner initiates the motor skill (memory trace) the movement produces an intrinsic sensory feedback that allows modification of their performance based on perceptual trace fostered by feedback and practice (Fitts and Posner, 1967 and Adams, 1971). This permits the learner to cognitively evaluate their instrumentation performance and detect errors between the desired outcome and their actual movement in order to modify it when needed.

3.2 Constructivism

The ability to develop fine motor skills in dental hygiene requires the learner to construct knowledge about the instrumentation skill and practice it in a preclinical setting. The theory of constructivism is based on a philosophical viewpoint that the learner constructs knowledge of the world from concrete experiences (Jorge, 2014). Constructivists do not perceive the teacher as the transmitter of information but rather a facilitator to guide the learner to construct knowledge based on their experiences. Social constructivism is based on Lev Semyonovich Vygotsky work that recognized the importance of social interactions during the learning process.

In dental hygiene, a social constructivism approach to learning is valued as the learner engages in dialogue with knowledgeable individuals (teacher and/or peer) to construct knowledge and master psychomotor skills. The aim of this study was to encourage novice dental hygiene students to learn probing (instrumentation) skills on a peer (experiential learning) and interact with an instructor to provide guidance (verbal feedback).

The Zone of Proximal Development as described by Vygotsky, is the stage of learning when students require guidance and feedback. As the learner improves their knowledge or masters a skill, mentoring is withdrawn, and the learner is able to work independently (Jorge, 2014). It is imperative educators examine methods to assist the learner to become better at self-assessment as they learn motor skills.

3.3 Experiential Learning Theory

Experiential learning requires the learner to engage in the activity employing experience and, through reflection during execution, perform a skill (Kolb, Boyatzis & Mainemelis, 1999). This theory is markedly different from the cognitive and behavioral learning theories that negate the function of subjective experience in the learning process (Kolb et al., 1999).

The experiential learning model is represented by a four-stage learning cycle: concrete experience, reflective experience, abstract conceptualize and active experimentation (Kolb et al., 1999). The learning process progresses as the learner encounters all four stages. The initial stage involves exposure to a new experience (concrete experience). This is followed by reflection on the experience (reflective observation) giving rise to new ideas related to the experience (abstract conceptualization). Finally, during the active experimentation stage, the learner implements an action in order to evaluate the results (Jorge, 2014). Novice dental hygiene students at JAC

encounter Kolb's four stage learning cycle as they grapple with new concepts of instrumentation in order to apply them in the preclinical course.

According to Kolb, in order to deepen ones understanding from an experience, the learner must actively engage in the activity, use analytical skills to reflect on the task, conceptualize the task, and implement problem solving skills to modify the desired outcome (Merriam, Caffarella, and Baumgartner, 2007).

In dental hygiene, critical to the learner's ability to perfect their instrumentation skills is the ability to reflect, analyze, evaluate and modify their performance in order to master the skill. In the early stages of motor learning novice dental hygiene students require a tremendous amount of guidance however in time, this external source of feedback is diminished as the learner comes to rely on their observational skills and intrinsic sensory feedback to perform the task. Experiential learning is crucial in the dental hygiene program as students apply instrumentation skills in a real-world setting (dental hygiene preclinical setting at JAC) on a peer.

3.4 Focus of Attention

A required goal in the dental hygiene program is for students to develop self-assessment skills in order to evaluate their performance and modify errors when needed (Asadoorian & Batty, 2005; Hauser and Bowen, 2009 and Mays & Branch-Mays, 2016). The skill must be demonstrated, and novice learners mentored to ensure their success in the program and subsequently in their professional careers. As novice dental hygiene students learn instrumentation skills it is imperative for educators to understand and implement the best teaching strategies.

Several studies have examined the effects of the learner's focus of attention when learning a motor skill. The guided instruction has the learner focus on their body part(s)

movement (internal focus of attention) or on an environmental source such as a golf club (external focus of attention). Wulf & Prinz (2001) examined the impact of internal and external focus of attention on motor skill performance. They concluded that if the learner's focus of attention was on an external source (i.e. golf club) their performance improved during the acquisition/cognitive and retention phases of learning (Wulf, 2007). Perkins-Ceccato, et al. (2003) conducted a study on novice and expert golfers and disagreed with Wulf & Prinz's findings. They determined an internal focus of attention is more beneficial for novice learners whereas more experienced participants should visualize on an external focus of attention to perfect their skills (Perkins-Ceccato, Passmore & Lee, 2003). The authors surmised that when novice learners were asked to focus on an internal focus of attention, their performance was more consistent overall. Perkins-Ceccato, et al. (2003) stated that once the fundamentals of the swing were learned the focus of attention should shift to an external source (golf club) to enhance the learner's performance

When dental hygiene students at JAC learn instrumentation skills initially they are encouraged to focus their attention on an internal focus of attention however once they initiate the body movement they shift their focus to an external focus of attention (probe). They are urged to gradually shift their focus of attention from their grasp (hand), maintaining a neutral wrist position to that of the probe tip adaption, tempo, walking distance and probe tip angulation to ensure accurate probing measurements on their patients.

It remains unclear if the learning process is affected when novice dental hygiene students focus on an external and internal focus of attention during motor learning. Wulf's predictions that novice learners should focus on an external source must not be discounted and warrants further investigation in the field of dental hygiene motor learning.

3.5 The Role of Feedback in Motor Learning

A main component underlying the behavioral approach to motor learning is feedback and it is defined as any kind of sensory information related to a movement (Schmidt & Craig, 2004). It is imperative educators choose the type of feedback conducive to the desired motor skill. Boyce (1991) stated KP feedback is imperative when teaching closed loop motor skills as it relates to the movement of the desired outcome. Sharma et al.'s, (2016) four-week study compared the role of KR and KP in learning a simple task. Participants were required, using their non-dominant hand, to throw a ball at a target. The researchers found that both types of feedback improved motor learning during the early phase of motor learning however KP feedback was statistically superior following a post-test. The authors contended that the reason for the significant improvement was that the learners focused on the repetitive arm movements and not the outcome of the throw. At JAC, KP feedback has been traditionally taught to dental hygiene students because of the imperativeness for the learner to be cognizant of their grasp, hand, fulcrum, activation and movement pattern to effectively implement the desired instrumentation skill.

The frequency of feedback has been widely researched in the field of motor learning. Boyce (1991) cited Thorndike's (1972) and Bilodeau & Bilodeau's (1958) work that supported frequent feedback to enhance motor skill learning and memory trace. In subsequent years, several KR studies opposed the earlier studies and reported that frequent feedback enhances motor skills in the early phase however is detrimental in the retention phase as the novice learner comes to rely on the external source of information (Winstein & Schmidt,1990 and Yao, Fischman, & Wang, 1994). Comparable results were shown in Young and Schmidt's (1992) knowledge of performance (KP) study that examined KP feedback after every trial following a

set of five trials in a simple batting task. The authors found that reducing KP feedback enhanced motor skill learning in the retention phase.

The aim in dental hygiene is for novice dental hygiene students to enhance their observational skills and intrinsic sensory feedback when learning instrumentation skills. I hypothesized that terminal KP verbal feedback is the preferable teaching strategy in dental hygiene because the learner has time to assess intrinsic sensory feedback (perceptual trace) and modify errors as they perform the skill. Terminal instructor verbal feedback will serve to enhance their understanding of what is required to modify their actions in subsequent practice trials.

It is fundamental to determine which verbal feedback frequency (50% or 100%) will best guide the novice dental hygiene student to enhance their observational skills and intrinsic sensory feedback, perform the skill accurately and retain it long term.

3.6 The Guidance Hypothesis

The guidance hypothesis predicted that frequent augmented feedback guides the novice learner to improve their performance during the early phase of learning however detrimental during the retention and transfer phases because they come to rely on the direction and fail to process the intrinsic sensory feedback (Adams, 1971 and Winstein et al., 1994). Schmidt and Bjork (1992) stated that learners who receive consistent feedback improve their skills in the initial phase of learning however struggle to reproduce them during the retention phase of testing. Performance was disrupted during the retention phase when feedback was removed or altered because learners came to rely on it in the early stages of motor learning (Anderson, Magill, Sekiya and Ryan, 2005; Schmidt and Bjork, 1992, Walsh, Ling & Wang, 2009 and Winstein, et al., 1994). When learners relied on feedback, they failed to implement cognitive

processes that encouraged them to self-assess skills (Winstein et al., 1994). Anderson et al. (2005) findings supported the guidance hypothesis as they observed that frequent feedback discouraged the learner from implementing intrinsic feedback inherent to the skill. The authors stated that failing to process intrinsic sensory feedback resulted in the learner's inability to ascertain motor skill errors (Anderson et al., 2005). Anderson et al. (2005) referred to Lange and Yonge (1990) findings that demonstrated when feedback frequency was reduced it provided optimal motor skill learning. They noted that the learner developed the ability to rely on intrinsic feedback to improve their performance. Anderson's study showed that reduced KR feedback encouraged learners to recognize intrinsic feedback essential to develop and retain motor skills. They found that learners noticed a greater variety of sensory cues when external feedback was reduced.

Wulf, Shea and Matschiner (1998) challenged the guidance hypothesis predictions when learning complex motor skills. They stated that high frequency feedback is beneficial for the learner until a certain level of competency is achieved. Wulf et al. (1998) maintained that previous studies examining relative frequency of augmented feedback on motor learning primarily investigated simple tasks using basic arm movements and neglected to examine complex motor skills. They found providing infrequent feedback (50%) during the six practice trials (ski simulator) when compared to 100% feedback led to poor error detection capabilities by the novice learner, resulting in an inability to modify their performance in the absence of external feedback (Wulf et al., 1998). Concurrent KR feedback was provided during each of the six-practice sessions conducted over six days (Wulf et al., 1998). Their findings contradicted the guidance hypothesis that predicted frequent augmented feedback might degrade performance outcomes on retention and transfer tests (Adam's, 1971 and Winstein et al., 1994). Wulf et al.

(1998) referred to Schmidt, Lange and Young's (1990) study that suggested for optimal learning of complex skills the novice learner benefitted from 100% augmented feedback when the skill was practiced during six practice trials. Most of the research findings that support reducing augmented feedback investigated a simple task conducted over multiple practice trials (Yao, Fischman & Wang, 1994). Wulf et al. (1998) cited Schmidt, Lange and Young's (1990) and Yao et al. (1994) work which stated when learning complex motor skills, the optimal number of trials should be considerably less than those utilized when studying simple tasks. Lange and Young's (1990) results revealed the optimal number of trials for learning complex motor skills was five. Learning to manipulate dental hygiene instruments is a slow methodical process in comparison to Wulf's ski slalom study that involved fast-paced discrete motor skills. It seems appropriate that the learner in Wulf's study be allotted additional verbal feedback to improve performance, as they cannot draw upon intrinsic sensory feedback. Her study involved the learner focusing on two variables of motor learning (frequency of variations and movement amplitude) that could not be intrinsically perceived. In dental hygiene, students are required to self-assess performance based on observation and intrinsic sensory feedback. Wulf et al. (1998) cautioned the reader not to make general assumptions from the literature regarding reducing the frequency of feedback in developing complex motor skills as it might be too demanding for novice learners who have little to no experience to modify errors during the early phase of motor learning (Wulf et al., 1998). This study attempted to answer if frequent verbal feedback is warranted when learning intricate instrumentation skills or should verbal feedback be reduced for learning to occur.

In dental hygiene novice learners are required to learn complex highly precise instrumentation skills in order to effectively treat their patients. As the learner practices the complex instrumentation skill they need to hone in on intrinsic sensory feedback and visual cues

to achieve competency. The purpose of this study was to compare the role of verbal feedback frequency (100% and 50%) when learning dental hygiene fine motor skills following six practice probing trials.

3.7 Research Questions

1. Which KP verbal feedback frequency (50% or 100%) is most effective in enhancing probing performance scores immediately following six probing trials (post-test).
2. Which KP verbal feedback frequency (50% or 100%) is most effective in enhancing probing performance scores one-week post probing trials (retentive test)?

Chapter 4: Methodology

Teaching fine motor skills to novice college dental hygiene students requires instructor expertise and the ability to impart feedback in a constructive manner. It is imperative dental hygiene instructors continually investigate evidence-based teaching strategies to foster relevant learning opportunities and improve the learners' preclinical performance.

4.1 Participants

A convenience sample was taken from second year CEGEP dental hygiene students (n=21 female and n=5 male) enrolled in a pre-clinical instrumentation course at John Abbott College in the fall of 2017. Student characteristics varied in age (n=19 to 45) and levels of education (23.1% had recently completed high school; 30.7% had previous college experience and 46.2% had acquired a university degree).

A discussion was led by a faculty member (dental hygiene chairperson) outside of the study with students in the Periodontal Instrumentation (pre-clinical) course to request their participation and ensure they understood the formative nature of their participation. They were informed of the aim of the research both verbally and in writing prior to commencement of the

study and told they could withdraw from the study at any time and that it would not affect their academic standing.

Students were assigned to their lab sections by the department's dental hygiene chairperson. Novice dental hygiene participants had no prior exposure to the experimental apparatus (probing skills). The student sample size was divided into a control group n=13 (100% KP verbal feedback frequency) and the experimental group n=13 (50% KP verbal feedback frequency).

This study was conducted with the approval of John Abbott College's ethics committee, Certificate number: JACREB201702.

4.2 Research Design

This study used a mixed method research design. Quantitative data analyzed the effectiveness of KP verbal feedback frequency (100% and 50%) on student's probing performance scores on a pre-test, post-test and retentive test. Students were asked to complete a confidential online qualitative survey and answer four open-ended questions in order to examine patterns and themes regarding their perceptions of the verbal feedback they received following the six probing trials.

4.3 Purpose of the Study

The purpose of this study was to investigate the role of verbal feedback frequency (50% and 100%) in the cognitive and retention phases of learning fine motor probing skills.

The independent variables of this study are: KP verbal feedback (100% frequency) following each of the six practice trials (IV-1) and KP verbal feedback (50% frequency) following trials 1, 3 and 5; with no feedback following trials 2, 4 and 6 (IV-2).

The dependent variables: (post-test) probing mean scores following six practice trials (DV-1) and (retentive test) probing mean scores when re-examined one week later (DV-2).

4.4 Null Hypothesis

Ho: There is no difference in the mean probing scores on a post-test following six probing trials and on a retentive test when re-examined one week later between the control group (100% KP verbal feedback frequency) and the experimental group (50% KP verbal feedback frequency).

4.5 Alternative Hypothesis

H_1: The most effective teaching method to enhance probing mean scores on a post-test is 100% KP verbal feedback frequency (IV-1).

H_2: The most effective teaching method to enhance probing mean scores on a retentive test is 50% KP verbal feedback frequency (IV-2).

In order to control for threats of internal validity, the content and theoretical format did not differ from last year's curriculum design and the course teacher remained the same. Instructor feedback is traditionally used in the dental hygiene curriculum to enhance knowledge and practical outcomes. Two JAC pre-clinical instructors met prior to the study to develop a plan to facilitate the type of verbal feedback (knowledge of performance), timing (terminal) and frequency (50% or 100%) within the control and experimental groups.

Three raters, unaware of the teaching strategy during the six practice trials, evaluated the participants pre-probing skills (beginning of lab prior to instructor feedback), post-test (end of six practice trials) and retention test (one week later) using a Probing Performance Evaluation Rubric from the pre-clinical course at JAC adapted from the course's textbook (Nield-Gehrig, 2013). A copy of this Rubric can be found in Appendix B. Permission from the author was granted for the purpose of this study (see Appendix E).

A rater was assigned to the same participant for each of the three probing performance tests. For calibration purposes the three raters met prior to the study to collaborate and discuss the Probing Performance Evaluation Rubric.

Students learned theoretical concepts of a periodontal probe (grasp, adaption, angulation and activation) in pre-clinical lecture format. They watched probing instructional videos with peers and the teacher in order to improve their cognitive understanding of proper probing techniques. The learner constructed knowledge in a classroom setting as they actively applied principles of probing on a (D955DP-200) 32 teeth soft pink clear gingiva-GS-E typodont.

A constructivist approach to learning is based on the learner's active participation in understanding the context and applying the skills to accomplish the learning activity. Students reviewed information using their assigned textbook on effective probing techniques prior to their pre-clinical lab and created study notes.

Participants were randomly assigned to the control or experimental group by a faculty member outside of the study. A total of six practice probing trials were conducted on a maxillary first premolar tooth during this study.

Control group: (KP) verbal feedback was provided to students after each of the six practice probing trials (100% frequency).
Experimental group: (KP) verbal feedback was provided to students following practice trials 1, 3 and 5; no feedback following trials 2, 4 and 6 (50% frequency).

Students in the control and experimental groups practiced probing skills using the Williams probe (PW6) on a peer. A pre-test (Probing Performance Evaluation Rubric) was given to the participants at the beginning of the preclinical session on tooth #24 (right-handed operators) or #14 (left-handed operators). The participants practiced probing skills during six practice trials. During each practice trial, students self-assessed their ergonomics (positioning), adjusted the client's head and chair according to the task, used a light modified grasp (finger

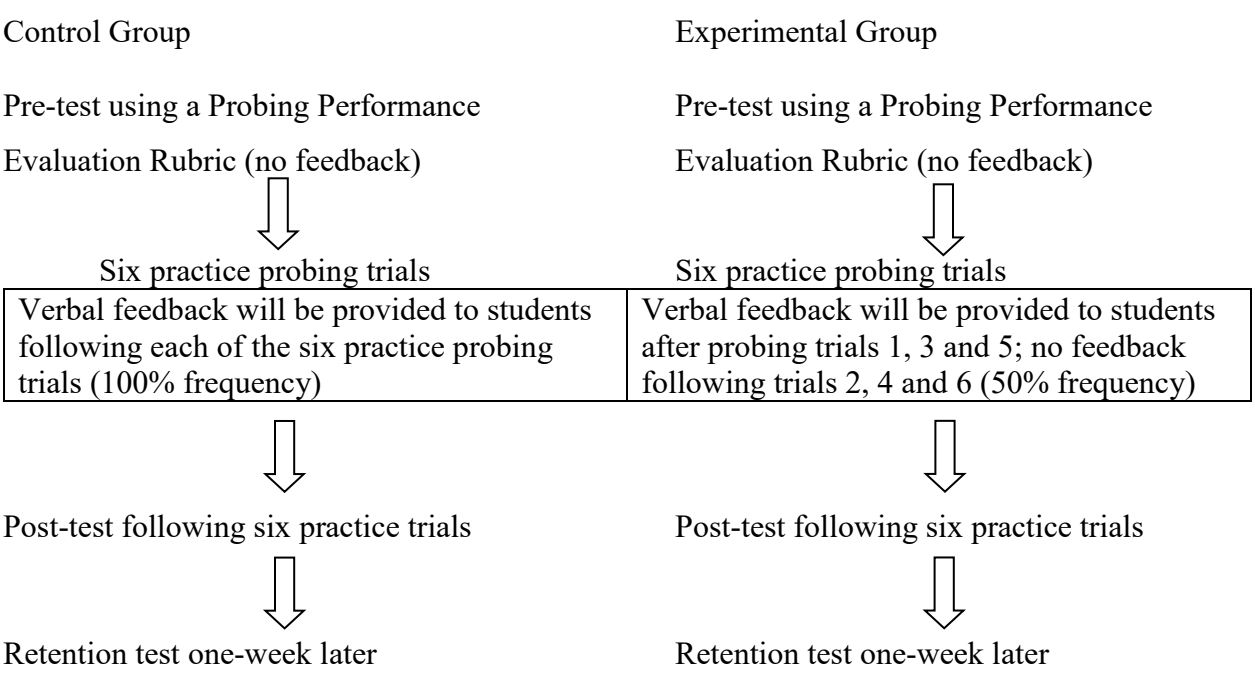
placement on the instrument), proper fulcrum (finger stability), adapted the probe tip against the tooth, and ensured proper probe angulation as they walked the probe below the gum line (1mm width) around the circumference of the assigned tooth. If the probe was not angled according to the tooth morphology, the probing results would not accurately represent the periodontium (oral health) of their peer. Students were provided verbal feedback by the instructor once the practice trial was completed (KP verbal feedback: 50% or 100% frequency).

During the study participants in the control and experimental groups were randomly assigned to an instructor who provided terminal KP verbal feedback. Instructor calibration exercises were conducted prior to the study in order to diminish the potential for instructor bias when verbal feedback was provided.

Data collection was conducted by three raters (not the researcher) and consisted of a pre-test prior to the six practice probing trials to assess their improvement on the post and retention tests.

Once they completed the six practice probing trials, learners were evaluated (post-test) on tooth #24 (right-handed operators) or #14 (left-handed operators) by their assigned rater. A retention test was conducted one week later to evaluate probing skills retention performance by the participant's assigned rater.

4.6 Chart 1: Study Flow Chart



4.7 Instruments

The quantitative component of the research consisted of evaluating students probing skills using a detailed probing rubric on a pre-test, post-test (following the six practice trials) and a retention test when examined one week later.

The grading of the students implemented a score of satisfactory (skill acquired) (√) or unsatisfactory (unable to perform the skill) (X) for each the 25 probing criteria. This method of evaluation diminished the possibility of instructor bias when evaluating students probing skills. As the intent of the study was skill acquisition and not measurement readings, the test scores were based on twenty-five of the twenty-six criteria in the Rubric (Appendix B). The item "Obtains measurement readings that are within 1mm of the evaluator's measurements." was omitted.

The qualitative component of the research had students complete a confidential online survey at the end of six practice probing trials.

Seven questions using a five-point Likert scale and four open-ended questions were examined for themes and patterns based on the amount of feedback they received and their perceived ability to practice independently following the six practice probing trials (see Appendix C). The four open-ended questions were as follows:

1. Did you have a clear understanding of the probing criteria prior to the six practice trials? If so how did you prepare? If not, what prevented you from understanding the probing criteria?
2. Was your instructor's verbal feedback suitable for you to improve your probing skills by the end of the six probing trials? Explain your answer.
3. Did you assess your grasp force, hand movement and probe tip angulation as you practiced probing on your peer or did something prevent you from focusing on them? If so which ones did you rely on? If not, what prevented you from self-assessing your skills?
4. Do you believe you now have the skills to assess your probing skills effectively on your own? Explain your answer.

4.8 Ethical Considerations

A discussion, led by someone outside of the study (chair of the Dental Hygiene Department) ensured students comprehended the formative nature of their participation and that they understood the exercise was not intended to harm their overall learning. Participants were informed their involvement was voluntary, they could withdraw from the study at any time and that it would not affect their academic standing. For written instructions see Appendix A.

Students did not receive remuneration for the study. They were informed that their participation and the information acquired throughout the study would enhance their learning and that of future dental hygiene students. The pre, post and retentive tests were strictly formative, and their participation or lack of participation would not affect their final grade. To ensure

fairness in their educational journey, students who received 100% KP verbal feedback during the study received 50% KP verbal feedback in a subsequent preclinical lab as they learned a new instrument. Those who received 50% KP verbal feedback received 100% KP verbal feedback during the same preclinical lab.

The dental hygiene teacher (not the researcher) coded the participants' names and the original list was locked in a filing cabinet in their office. Persons who read the data were unable to link the participant's name to their results. The assigned participants' codes ensured confidentiality during data collection and analysis.

Each rater, not the researcher, was assigned to the same participant for the pre, post and retention test to ensure continuity. During the probing tests, raters were unaware of which KP verbal frequency (100% or 50%) the participant received during the six practice probing trials. The participants' graded probing rubric was coded to ensure confidentiality from the researcher.

Participant's probing performance test results were stored in a locked cabinet in the researcher's office until the completion of the thesis. Data analysis was stored on a password secured hard drive and will be destroyed after 5 years. Once the study was written and completed the related documentation was stored in the Finance and Legal Affairs department under lock and key where it will remain for five years after which it will be destroyed by the researcher.

Students were informed of the study's results during a clinical course (Winter 2018 semester) in order to reinforce faculty commitment to their learning success. The study was conducted in a professional and ethical manner. The focus was on student learning.

4.9 Study Challenges

The study intended to use one rater to evaluate the pre, post and retentive probing performance skills of the participants. A mock simulation was conducted one week prior to the

study as students learned an instrument unrelated to the probe. It was determined that to effectively evaluate all the participants' pre, post and retentive tests and given the allotted time, one rater would be insufficient. To ensure calibration (consistency of grades, equity amongst raters, etc.), raters were assigned to evaluate the same students' pre, post and retentive tests. Three raters met prior to the study to ensure this calibration met all the criteria so as to ensure fairness and consistency within the study.

Chapter Five: Presentation of Findings

The participants were subjected to a pre-test (prior to any verbal feedback), post-test following the six practice probing trials and retentive test conducted one week after the last probing trial using the Rubric as detailed in Appendix B. Probing performance scores were compared using a t-Test: Two-Sample Assuming Equal Variances. The student's attitudes and perceptions regarding the verbal feedback they received and their perceived ability to effectively practice probing in the absence of feedback were assessed using a five-point Likert scale and four open ended questions.

5.1 Results

Twenty-seven students enrolled in the dental hygiene pre-clinical course agreed to participate in the study. The inability of one student to attend the pre-clinical lab the day of the study (participation rate= 96.3%) necessitated said student's disqualification.

The quasi-experimental design compared verbal feedback following each of the six practice trials and ~~50%~~ verbal feedback following trials 1, 3 and 5; no feedback following trials 2, 4 and 6 to determine which verbal feedback teaching method, if any, was more beneficial when learning probing skills.

Using Microsoft Excel 2016, a t-Test: Two-Sample Assuming Equal Variances was used to analyze the control and experimental group's mean probing performance scores on a pre, post and retentive tests. The variances of the two groups were deemed equal based on the F-test ($F=1.666202 < F$ critical$= 2.686637$) following the pre-test.

Although the mean probing score results for the experimental group was slightly higher than the control group on the pre-test they did not show a statistical significant difference

(p=0.54298) between the two groups (see table 1). The similar pre-test results revealed neither group demonstrated enhanced fine motor skills prior to receiving instructor feedback.

Table 1: Comparison of the mean probing scores following the pre-test (Rubric based on 25 probing criteria)

Groups	Student's performance scores		student's t-test
	Mean	SD	
Control (100%)	15.84615385	3.71587033	p=0.54298
Experimental (50%)	16.88461538	4.796499792	

SD: Standard deviation

The post-test probing mean scores showed no statistically significance difference (p=0. 801837825) between the control and experimental group following six practice trials (see table 2).

Table 2: Comparison of the mean probing scores following the post-test (Rubric based on 25 probing criteria)

Groups	Student's performance scores		student's t-test
	Mean	SD	
Control (100%)	21.61538462	2.762501	p=0.801837825
Experimental (50%)	21.30769231	3.388328383	

SD: Standard deviation

The retentive test probing mean scores showed no statistically significance difference (p=0.798163833) between the control and experimental group conducted one week later (see table 3).

Table 3: Comparison of the mean probing scores following the retentive test (Rubric based on 25 probing criteria)

Groups	Student's performance scores		student's t-test
	Mean	SD	
Control (100%)	21.42308	2.049859	p=0.798163833
Experimental (50%)	21.1538462	3.1450001	

SD: Standard deviation

Chapter 6: Discussion

This study investigated the impact of KP instructor verbal feedback frequency (100% and 50%) as students learned to probe a maxillary premolar tooth (cognitive phase) on a peer following six practice trials on a post-test. Probing performance skills were also assessed on a retentive test when re-examined one week later.

The challenge for dental hygiene instructors is to gage when and how much verbal feedback is beneficial to enhance the learners' ability to self-assess performance when learning instrumentation skills. KP verbal feedback was chosen for this study in order to encourage students to assess their observational cues and intrinsic sensory feedback as they executed the task of probing a maxillary first premolar.

In previous years at JAC, instructors provided feedback to students as they learned to probe on a manikin within a four-hour pre-clinical lab setting. The instructors determined students were solely relying on instructor verbal feedback resulting in the inability to retain their probing skills in subsequent weeks. Previous years observations seemed to support the guidance hypothesis that stated that in the absence of external feedback, the learner's performance during the retention phase is limited because they come to rely on the verbal feedback during the cognitive phase of motor learning (Anderson, Magill, Sekiya and Ryan, 2005; Park, Shea & Wright, 2000 and Winstein et al., 1994). Winstein et al. (1994) stated, when learners rely on feedback they fail to implement cognitive processes that encourage them to self-assess their skills. The four-hour pre-clinical labs most certainly contributed to information overload among the learners. They were unable to self-assess probing skills leading them to rely on instructor feedback in subsequent labs. After reading Wulf's et al. (1998) study on learning complex motor skills the researcher decided to limit the number of practice probing trials to six. The author

stated when novice learners are learning complex motor skills the number of trials should be reduced and feedback should be given following each attempt (Wulf, 2007; Wulf et al., 1998).

The literature is divided as to whether feedback should be withheld to promote self-assessment and discourage the learner from relying on instructor feedback (Guidance Hypothesis) or if feedback should be conducted after each practice trial due to the complexity of the skill (Wulf, 1998). The literature that supports the guidance hypothesis examined simpler motor skills over many practice trials. Their findings suggested that feedback should be reduced in order for the learner to self-assess their skills (Anderson, Magill, Sekiya and Ryan, 2005; Schmidt and Bjork, 1992, Walsh, Ling & Wang, 2009 and Winstein, et al., 1994).

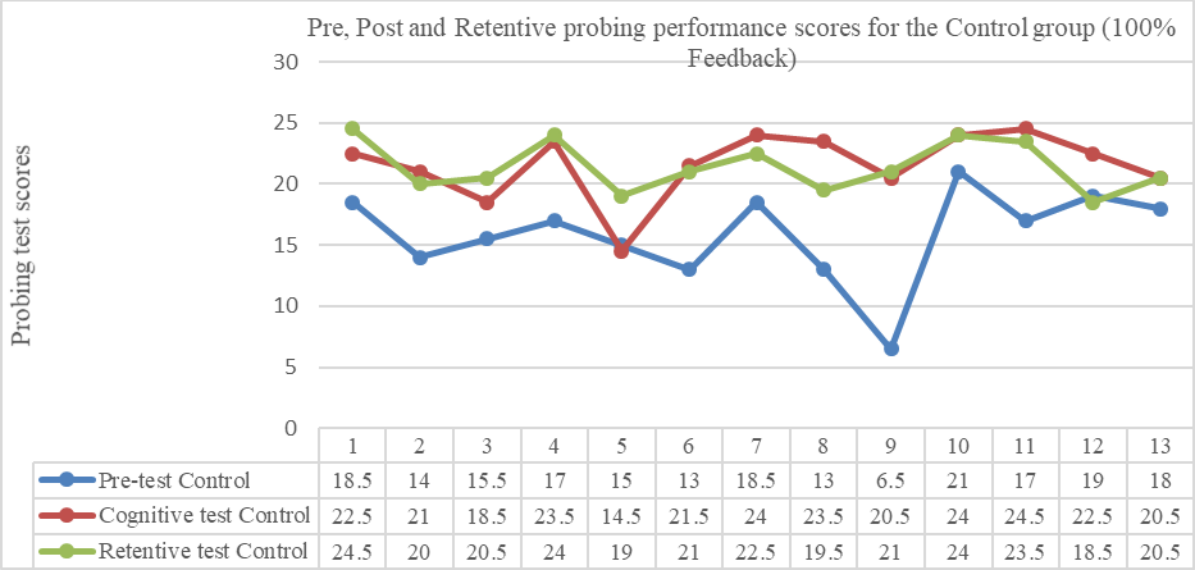
The intent of the study was to determine if mastering fine motor skills in dental hygiene required frequent verbal feedback due to the complexity of the desired task, or if instructors should reduce the amount of verbal feedback to encourage students to independently problem solve as they probe in order to modify their actions in the absence of feedback.

Students must relate probing (instrumentation) criteria to their performance and modify their actions based on their intrinsic sensory feedback and visual cues. The study's findings showed that reducing the practice time to six practice probing trials on a peer encouraged the learner to rely on the feedback they received and promote self-assessment as they progressed in their learning journey. Although the mean scores of the control group (100% KP verbal frequency) was slightly higher than the experimental group (50% KP verbal frequency), no statistical difference was found during the retentive test. The results of the present study confirmed the need to limit the number of practice trials when learning to use new instruments. It challenges the learner to rely on their ability to assess their instrumentation skills and does not overload the learner with an abundance of instructor feedback. The results of the study, though

not supportive of the guidance hypothesis or Wulf's findings, will be beneficial to future preclinical instruction. The researcher concluded four-hour instrumentation labs conducted in previous years were counterproductive to students learning. Future pre-clinical instruction will have students learn to probe on a peer limiting the number of practice trials to six.

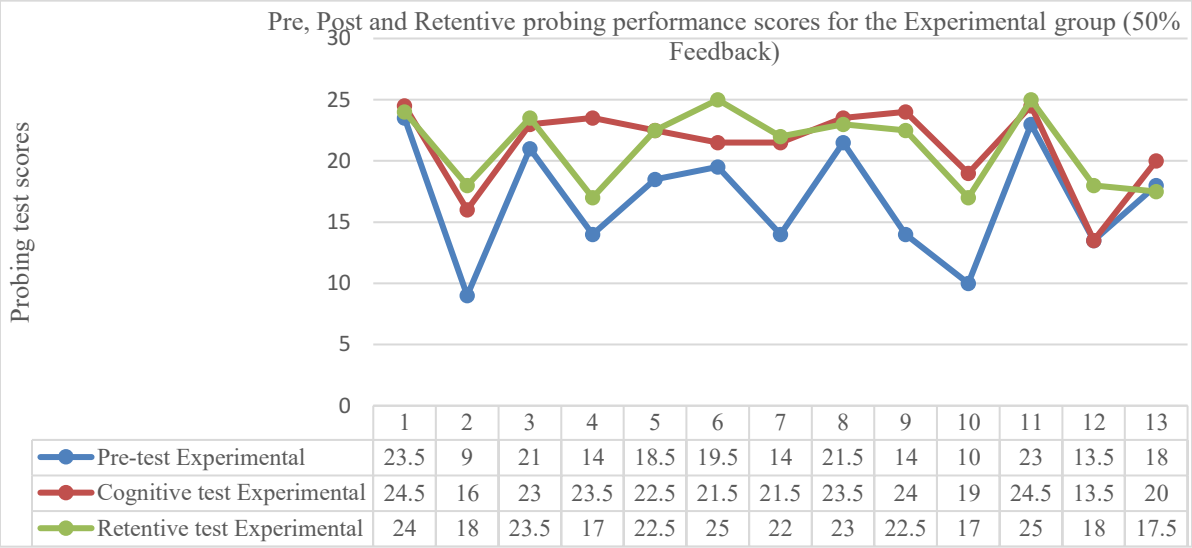
This study accepted the null hypothesis because neither the control nor experimental group outperformed the other on the post and retentive probing tests. The findings did however demonstrate that KP verbal feedback significantly improved the learner's probing performance skills on the post and retentive tests (see Line graphs 1 and 2).

Line graph 1: Pre, Post and Retentive individual probing performance tests for the Control group



	1	2	3	4	5	6	7	8	9	10	11	12	13
Pre-test Control	18.5	14	15.5	17	15	13	18.5	13	6.5	21	17	19	18
Cognitive test Control	22.5	21	18.5	23.5	14.5	21.5	24	23.5	20.5	24	24.5	22.5	20.5
Retentive test Control	24.5	20	20.5	24	19	21	22.5	19.5	21	24	23.5	18.5	20.5

Line graph 2: Pre, Post and Retentive individual probing performance tests for the Retentive group



	1	2	3	4	5	6	7	8	9	10	11	12	13
Pre-test Experimental	23.5	9	21	14	18.5	19.5	14	21.5	14	10	23	13.5	18
Cognitive test Experimental	24.5	16	23	23.5	22.5	21.5	21.5	23.5	24	19	24.5	13.5	20
Retentive test Experimental	24	18	23.5	17	22.5	25	22	23	22.5	17	25	18	17.5

The researcher expected to find that learners who received 100% verbal feedback would outperform those who received verbal feedback 50% of the time on the post (cognitive) test. Novice learners often require more guidance in the cognitive phase of psychomotor learning then during the associative phase. As the learner practices and reinforces their understanding of the acquired task, mentoring is reduced, and students are able to work independently. The post-test results demonstrated similar findings in the two groups. Wulf's study stated novice learners require more feedback during the cognitive stage of learning complex skills (1998). The researcher expected to find that the absence of feedback in the experimental group should have translated in poorer performance scores. In the control group 84.6% of students scored equal or greater than twenty probing criteria based out of a possible score of twenty-five (see Line graph 1). Surprisingly, in the experimental group, 76.9% of students scored greater then twenty probing criteria (see Line graph 2). The higher results in the absence of instructor feedback could be attributed to student preparedness, level of maturity, and an ability to self-evaluate performance when learning a new skill. Jackson & Tipton Murff (2011) stated dental hygiene students are

required to analyze their skills and modify them to ensure they provide their patients optimal care. In dental hygiene the capacity to self-assess and reflect on one's learning is critical to future success.

On the retentive test, 54% of students in both groups matched or outperformed their post-test score. The findings suggested most students were capable of problem solving and assessing their actions as they probed a peer's tooth. The lowest score in the experimental group on the retentive test was of 68% and 74% in the control group. A crucial component to learning for dental hygiene students is to modify actions in order to improve motor skills. A positive component to the study was reducing the amount of practice trials students received as they learned a new instrument. The results of the study clearly demonstrated that expert verbal feedback is beneficial to the motor learning process.

The online survey results showed that 73.1% felt prepared for the pre-clinical lab. This cohort's background of a higher level of education and maturity may have contributed to the positive results in their learning process.

Students wrote,

> "Yes, I prepared by reading the power points and watching the instructional videos. By practicing on a manikin I was able to really play around and get a feel for the instrument. Coming to lab I felt prepared enough that I new what was supposed to be done, even though I couldn't always perform what I saw in my head. There were definitely several things that I only realized once in lab and anything that I didn't really understand in theory, became clearer with the instructor's guidance".

> "Yes, I went through the voice over PowerPoint and made notes. I always watched the videos before lecture and lab".

Students who did not have a clear understanding of the probing criteria did not follow the recommended strategies suggested by the teacher. Students were asked to watch an instructional probing video and participate in class with peers and the instructor to reinforce probing concepts.

During class time, the teacher observed that a few students seemed disengaged in the probing active learning activity. The online survey comments revealed:

> "I was not sure I understood correctly the technique prior to lab. I tried to hold the pen grasp in a way that I can practice with imagining it was my probe. I should have practiced probing motion as well".

> "I kind of did. I had seen the videos and I had practiced a little in class. However, once I was in lab, I was a little lost, I didn't know how to position properly and honestly I don't think I could've done anything to prepare more since we weren't allowed to practice and watching videos and doing it in real life are two completely different things".

Some students may have been overwhelmed with the prospect of working on a peer in week two of the semester. Learning a new instrument is often challenging for students and working in a real life clinical setting on a person may impede the ability of some to process and problem solve without being overly concerned with the potential of hurting their peer. A student wrote,

> "I feel as if I had a good idea of what to expect, the only thing that I didn't like is that I feel as if we didn't have enough time to learn about the probe. (for example, before working on our peers I would've liked to practice on Dexter (manikin head) first to get a feel for it rather than diving right in".

The literature in the field of dental hygiene stated that students need to develop self-assessment skills in order to evaluate their performance and modify errors when needed (Asadoorian & Batty, 2005; Hauser and Bowen, 2009 and Mays & Branch-Mays, 2016). As novice dental hygiene students learn instrumentation skills, it is imperative for educators to understand and implement the best teaching strategies. This study demonstrated that KP verbal feedback is a very good teaching strategy to encourage learners to self-assess in order to improve their fine motor skills in the field of dental hygiene. Limiting the number of practice trials is fundamental when learning complex fine motor skills. Wulf's study suggested that limiting the number of practice trials to six is ideal when learning complex motor skills (1998).

Students were asked the following question on the online survey: Did you assess your grasp force, hand movement and probe tip angulation as you practiced probing on your peer or did something prevent you from focusing on them? If so which ones did you rely on? If not, what prevented you from self-assessing your skills? Some of their comments follow:

> "I did practice all these skills. In fact, these are all the things my instructor told me I needed to practice and work on. I was so off in the beginning but managed to do well after".

> "Yes, I assessed them all. My grasp force and my hand movement were fine but I have to practice more on the probe tip angulation specially on the interproximal".

> "Grasp force was a little hard to focus on since I was so focused on stroke and adapting properly, but every time I focused on my grasp everything really improved. I was able to focus on probe tip angulation fairly well. Adapting to the tooth properly was more of a priority in my head since I felt that would ensure that I wouldn't hurt my peer and it helped with probe tip angulation".

> "I normally have trouble when it comes to my grasp. Surprisingly, on that day it was very light, I was shocked. I was focusing a lot on the angulation to the point where it was too much. My instructor advised me and gave me tricks on how I can keep the same and steady angulation all throughout the surface until reaching the contact points".

> "Yes. I focused on angulation of probe tip and hand movement as I am already improving with light grasping".

> "I tried my best to focus on all aspects while probing but it is difficult at this stage to focus on all aspects, therefore during each feedback I tried improving one specific skill at a time".

Students were then asked the following question: Was your instructor's feedback suitable for you to improve your probing skills by the end of the six probing trials? Explain your answer.

Students wrote,

> "Yes, I received a few pointers at a time so it wasn't overwhelming. After each assessment I was able to think about what was advised and then try it on my own. I liked this since I was able to apply what I learned right away and recognize what I have to do in order to improve. I liked having my own time to figure it out, it gave

me time to think. However, the feedback is really important since there are so many details to remember and I can't keep track of all my mistakes myself".

"Yes, because at the beginning I was not able to do it but after the instructor give me the feedback I was able to do it. (not 100% right because I need to practice more)".

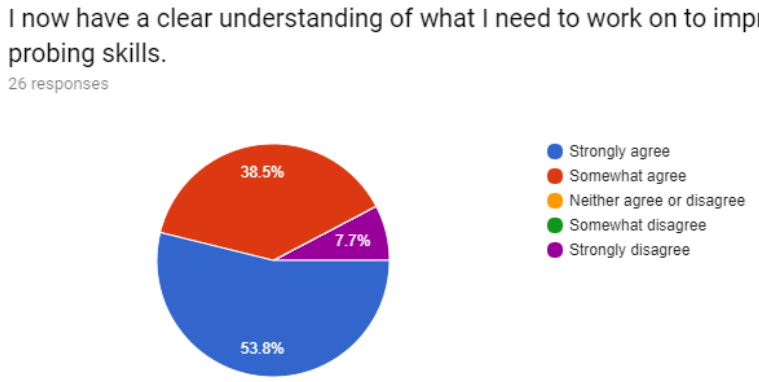
"Yes of course, especially to sit in correct position and adapting the probe tip angulation, I had problem, but after I've received 2-3 feedback I could figure it out".

"Yes, I found all the information extremely helpful. I got positive feedback on certain things, and also negative feedback on skills I need to improve. This is important to me, so that I know what I need to be focusing on more to improve my instrumentation skills. It is also encouraging getting positive feedback, it give you motivation to practice more and do better".

"The instructor feedback was suitable to improve my skills not only for probing but also for my ergonomics and my indirect vision while probing buccal and lingual surfaces".

Following the six probing trials students were asked if they felt they clearly understood the probing criteria. The survey showed 53.8% strongly agreed, 38.5% somewhat agreed and 7.7% did not believe they could improve their skills without instructor feedback (see Chart 2).

Chart 2



Students wrote,

"Yes, I feel more relaxed and got an answer to the questions I was asking myself prior to the lab".

> "Yes, because the instructor give me all the feedback I need to be able to assess my probing skills".

Some students still required guidance and wrote,

> "I think I like having someone to look at what I'm doing and to tell me if I'm doing it right. However, if I happen to practice alone, I try to problem solve and find the right position, but I feel it's always better to have someone tell you what you're doing wrong so you stop doing it before it becomes a habit".

As an educator, it is my role to create a learning environment that promotes observational skills, decision making and the transfer of knowledge from the didactic to the preclinical setting.

Constructivist learning theory is based on learners' active participation in grasping or comprehending the context and applying the skills to accomplish the learning activity. In both groups they were encouraged to actively assess their skills while learning to probe. Students were asked the following open-ended questions: Do you believe you now have a better ability to assess your probing skills effectively on your own? Explain your answer. Student's wrote,

> "I feel that I have definitely improved, I am more comfortable with the probe but I am nowhere near perfect. I think I would be able to assess myself but only for the specifics that were pointed out to me during lab. I like being able to work on my peer alone for just a few minutes so I can figure certain things out by myself. I also like having an instructor pointing out my flaws. At this point I don't feel comfortable without an instructor since I've only learned the basics. I don't want to end up picking up bad habits and not having an instructor catch them in time. I would still like to be assessed by my instructors but from specifically what I learned today I would be okay with assessing and perfecting myself".

> "Yes, since l receive a lot of feedback from my instructor and I wrote my weakness points, l have a better ability but not completely. l still need the feedback for working on another area. I think, l still need instructor observation and her feedback, since she is more expert than me".

Some students did not believe they had acquired the ability to self-assess their skills and felt they required additional instructor feedback. Two students wrote,

> "Definitely no. I would still need my instructor's guidance and feedbacks".
> "No because I still I was not sure if I was probing properly and efficiently".

During the acquisition phase of this study students were brought to a point of disequilibrium through problem solving as they learned to process how to probe. They were then encouraged through practice to perfect their skills in a preclinical setting. It is incumbent upon instructors to be mindful that some students require more guidance due to a lack of self-confidence during the acquisition phase of motor learning. The ability for teachers to assess a learner's educational needs is fundamental to the teaching process.

Chapter 7: Conclusion

Supporting dental hygiene students in the acquisition of fine motor skills involves numerous teaching methods, one of which being verbal feedback. By analyzing the effectiveness of two strategies with regard to the frequency of feedback, the researcher determined there was no statistically significant difference between the control group (100% frequency) and experimental group (50% frequency) on the post and retention probing performance tests.

During the cognitive phase of motor learning dental hygiene students received verbal feedback in order to perfect their skills in subsequent practice sessions. The disadvantage to providing frequent verbal feedback is that some novice learners come to rely on the instruction to perform the desired task. The role of verbal feedback is to guide and motivate the leaner in the early phase (cognitive) of motor learning. An important aspect of learning in the dental hygiene program is the students' ability to self-assess through practice. The goal is for students to achieve a high level of self-reliance and competency.

Based on the researcher's past teaching experiences, it was hypothesized that the experimental group would outperform the control group on the retentive test as, in the absence of feedback, learners were required to problem solve and modify their actions. The findings however demonstrated that verbal feedback, following the cognitive and retention phases of learning regardless of frequency, positively impacted probing performance scores of both groups.

Experiential learning is crucial in the dental hygiene program as students apply instrumentation skills in a simulated real-world setting on a peer (JAC dental hygiene preclinical setting). Students reported that having the opportunity to work on a peer lead them to realize the

importance of the task. They placed more value on the learning process and took the exercise more seriously than they had when working on a manikin. Reducing the amount of practice time from a four-hour probing lab on manikin to six practice trials on a peer was a critical factor that helped to ensure and promote instrumentation skills acquisition and retention. Instructors noted that students were more self-reliant in subsequent practice sessions. The reduced practice trials seemed to encourage learners to problem solve during active learning and not solely rely upon instructor feedback.

Feedback is a well-researched teaching strategy to enhance student learning. The online survey revealed that 84.6% of participants strongly agreed and 16.4% somewhat agreed that the feedback they received positively impacted their fine motor skills acquisition.

The author suggests that future research in dental hygiene include a larger sample size, evaluation of a maxillary and mandibular molar tooth to increase the complexity of the skill, and one rater (as opposed to three used in this study) to ensure consistency.

The results of this study were shared with the participants, dental hygiene colleagues and the John Abbott College teaching community.

The study's results will be used to guide preclinical instruction at JAC in subsequent cohorts to enhance dental hygiene fine motors skills. The findings revealed that reducing the practice time to six trials on peer encouraged students to rely on the feedback they received and promote self-assessment as they progress into the associative phase of learning.

Bibliographical References

Adams, J.A. (1971). A closed-loop theory of motor learning. Journal of Motor Behavior, 3, 111-150.

Anderson, D. I., Magill, R. A., Sekiya, H. and Ryan, G. (2005). Support for an explanation of the guidance effect in motor learning. *Journal of Motor behavior. 37*(3), 231-8.

Asadoorian, J. & Batty, H. (2005). An evidence-based model of effective self-assessment for directing professional learning. *Journal of Dental Education, (69),* 12, 1315-1323.

Boyce, B. A. (1991). The Effects of an Instructional Strategy with Two Schedules of Augmented KP Feedback upon Skill Acquisition of a Selected Shooting Task. *Journal of Teaching in Physical Education. (11),* 47-58.

Canadian Dental Association (2017). Gum Disease FAQs. Retrieved June 6th, 2017 from https://www.cda-adc.ca/en/oral_health/faqs/gum_diseases_faqs.asp.

Fitts, P. M., (1964). Perceptual motor skill learning. In A. W. Melton (Ed.). *Categories of human learning.* New York Academic Press. pp.243-285.

Fitts, P. M. & Posner, M. I. (1967). *Human Performance.* Brooks/Cole Pub. Co. Belmont, CA.

Fitts, P. M. & Posner, M. I. (1979). *Human Performance.* Reprint of the ed. Published by Brooks/Cole Pub. Co.

Hauser, A. M., & Bowen, D. M. (2009). Primer on preclinical instruction and evaluation. *Journal of Dental Education. 73*(3), 390-8.

Henry, F. M. & Rogers, D. E. (1960). Increased response latency for complicated movements and a “Memory Drum” theory of neuro motor reaction. *Research Quarterly for Exercise and Sport. 31*, 448-458.

Jackson, S. C., & Tipton Murff, J. (2011). Effectively Teaching Self-Assessment: Preparing the Dental Hygiene Student to Provide Quality Care, *Journal of Dental Education. 75*(2), 169-179.

Jorge, T-P. (2014). Peer-assessment within Dental Education. Dissertation. King's College London.

Kolb, D. A., Boyatzis, R. E. & Mainemelis, C. (1999). Experiential Learning Theory: Previous Research and New Directions. Department of Organizational Behavior, Weatherhead School of Management, Case Western University.

Magill, R. A. (1993). Augmented feedback is skill acquisition. In R. N. Singer, M. Murohey, and L. K. Tennant (eds). *Handbook of research on sport Psychology*, 193-212.

Mays, K. A. & Branch-Mays, G. L. (2016). A Systemic Review of the Use of Self-Assessment in Preclinical and Clinical dental education, *Journal of Dental Education, (80),* 8. 902-913.

Merriam, S. B., Caffarella, R. S., & Baumgartner, L. M. (2007). Learning in adulthood: a comprehensive guide. San Francisco: John Wiley & Sons, Inc.

Mononen, K., Viitasalo, J.T., Konttinen, N. & Era, P. (2003). The effects of augmented kinematic feedback on motor skill learning in rifle shooting. *Journal of Sports Sciences, (21)*, 867-876. doi: 10.1080/0264041031000101944

Nield-Gehrig, J. S. (2013). *Fundamentals of Periodontal Instrumentation and Advanced Root Instrumentation*. (8th Ed.). Toronto, ON: Lippincott Williams & Wilkins.

Park, J-H, Shea, C. H. & Wright, D. L. (2000). Reduced-frequency concurrent and terminal feedback: A test of the guidance hypothesis. *Journal of Motor Behavior, 32*, 287-296.

Perkins-Ceccato, N., Passmore, S. & Lee, T. (2003). Effects of attention of focus depend on golfers' skill. *Journal of Sports Science, (21)*, 593-600. doi: 10.1080/0264041031000101980

Roessger, K. (2010). Adult Learning Perspectives and Motor Learning Models: An Investigation of Commonalities. Retrieved from *https://msu.edu/~mwr2p/Roessger-MR2P-2010.pdf*

Salmoni, A.W., Schmidt, R. A., Walter, C. B. (1984). Knowledge of results and motor learning: a review and critical reappraisal. *Psychol Bull, (95),* 3, 355–86. doi:10.1037/0033-2909.95.3.355

Sattelmayer, M., Elsig, S., Hilfiker, R. & Baer, G. (2016). A systematic review and meta-analysis of selected motor learning principles in physiotherapy and medical education. *BCM Medical Education,* (16),15. doi: 10.1186/s12909-016-0538-z

Schmidt, R.A. (1991). Frequent Augmented Feedback can degrade learning; Evidence and Interpretations, *J. Requin and G. E. Stelmach (eds), Tutorials in Motor Neuroscience*, 59-75.

Schmidt, R. A. & Lee, T.D. (2005). Sensory contributions to motor control. *Motor control and learning: a behavioral emphasis, 4,* 125-162.

Schmidt, R. A., & Wrisberg, C.A. (2004). *Motor learning and performance*. Champaign, IL: Human Kinetics. ISBN 978-0-7360-4566-7

Sharma, D. A., Chevidikunnan, M. F., Khan, F. R. & Gaowgzeh, R. A. (2016). Effectiveness of knowledge of results and knowledge of performance in the learning of a skilled motor activity byhealthy young adults. *Journal of Physical Therapy, (28)*, 1482-1486.

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, *2*, 53–55. Retrieved from https://doi.org/10.5116/ijme.4dfb.8dfd

Walsh, C. M., Ling, S. C., Wang, C. S. & Carnahan, H. (2009). Concurrent versus terminal feedback: it may be better to wait. *Academic Medicine, 84*(10), S54-S57.

Weeks, D. L., & Kordus, R. N. (1998). Relative frequency of knowledge of performance and motor skill learning. *Research Quarterly for Exercise & Sport, 69*, 224-230.

Wierinck, E, Puttmans, V. & van Steenbergheet, D. (2006). Effect of reducing frequency of augmented feedback on manual dexterity training and its retention. *Journal of Dental Education, 34* (9), 641-647.

Winstein, C. J. & Schmidt, R.A. (1990). Reduced frequency of knowledge of results enhances motor skill learning. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 16,* 677-691.

Winstein, C., Pohl, P., and Lewthwaite, R. (1994). Effects of Physical Guidance and Knowledge of Results on Motor Learning: Support for the Guidance Hypothesis, *Research Quarterly Exercise Sport*, *65*(4):316-23. http://dx.doi.org/10.1080/02701367.1994.10607635

Wulf, G. (2007). Attentional focus and motor learning: A review of 10 years of research. *E-Journal Bewegung und Training, 1*(2-3), 1-11. https://scholar.google.ca/scholar?hl=en&as_sdt=0%2C5&q=Attentional+focus+and+motor+learning%3A+A+review+of+10+years+of+research&btnG=

Wulf, G., Shea, C. H. & Matschiner, S. (1998). Frequent feedback enhances complex motor skill learning. *Journal of motor behavior, 30*(2), 180-192. https://doi.org/10.1080/00222899809601335

Yao, W. X., Fischman, M. G. & Wang, Y. T. (1994). Motor skill acquisition and retention as a function of average feedback, summary feedback, and performance variability. *Journal of motor behavior, 26*(3), 273-282. https://doi.org/10.1080/00222895.1994.9941683

Young, D. E. and Schmid, R.A. (1992). Augmented kinematic feedback for motor learning. *Journal of Motor Behavior. (24)*, 261-273. https://doi.org/10.1080/00222895.1992.9941621

Appendix A

Consent form and written explanations of the study for participants

Appendix A

The role of augmented feedback timing and frequency in the acquisition of fine motor instrumentation skills in dental hygiene.

Researcher:	Debbie DesRivieres	Tel:
Email	debbie.desrivieres@johnabbott.qc.ca	
Dept	Dental Hygiene	
Supervisor:	Murray Bronet	Tel:

Dear Student:

You are being asked to participate in the above research study in which we are investigating the role of feedback frequency when learning practical dental hygiene skills.

Research Questions

1. Which verbal feedback frequency (50% or 100%) is most effective in enhancing probing performance scores immediately following six probing trials (post-test).

2. Which verbal feedback frequency (50% or 100%) is most effective in enhancing probing performance scores one-week post probing trials (retentive test)?

Purpose of the research:

The purpose of this research is to determine the optimal frequency (50% or 100%) of knowledge of performance feedback at the end of the instrumentation skill (terminal) in promoting fine motor skills acquisition and retention in novice dental hygiene students.

What is involved in participating?

You will learn theoretical concepts of a periodontal probe (grasp, adaption, angulation and activation) in their Periodontal Instrumentation class. You will be asked to watch probing instructional videos with peers and the teacher in order to apply principles of probing on a (D955DP-200) 32 teeth soft pink clear gingiva-GS-E typodont.

You will review information using the assigned Periodontal Instrumentation textbook on effective probing techniques prior to lab and create your own study notes.

Students in both experimental groups will practice probing skills using the Williams probe (PW6) on a peer. A practical pre-test (Probing Performance Evaluation Rubric) will be given to

the you at the beginning of the lab session on tooth #24 (right-handed operators) or #14 (left-handed operators). During your lab session, you will practice probing skills during six practice trials.

You will participate in three probing performance tests; pre, post-cognitive (early) phase and retention phase test (one week later). You will be asked to complete a confidential online survey following the six experimental practice sessions to examine your perception of the feedback and frequency you received during the six practical probing trials. Your answers will be collected by the dental hygiene chairperson and coded to ensure confidentiality.

There will be no way for anyone reading the results of this study to be able to link any data with your name or student number. PSEUDONYMS WILL ALWAYS BE USED in any publications that may result from this study, as well as in the stored data. If you withdraw from participation as a participant at a later date, all data of any kind will be erased and/or destroyed.

Participation, or lack of participation in this research will NOT affect your grades in any way. Your participation is entirely voluntary and you may choose to withdraw at anytime.

Confidentiality means that no person at John Abbott College, or any other organization will have access to the materials collected and that they will be coded and stored in such as way as to make it impossible to identify them directly with any individual. All names will be changed in the stored data and resulting publications. Data will be stored on a password secured hard drive, and will be destroyed after 5 years. All other type of information (audio-tapes, cd's, paper copies) will be stored in a locked filing cabinet and will be erased and/or destroyed after 5 years.

Student's signature:

STUDENTS: please tick the appropriate box, sign, date and return to …

☐ I have read and understood the information provided on the consent form, and I agree to participate in this study. I understand that my participation is voluntary, I may withdraw from participation at any time, and my academic standing will NOT be affected in any way by consenting or not consenting to participate in this study.

☐ I do not consent to participate in the described study.

Student's name (print): _____
First name, Last name

Student's signature: _____ Date: _____
signature dd / mm / yyyy

Researcher's signature: _____ Date: _____
signature dd / mm / yyyy

IF STUDENT IS UNDER THE AGE OF 18, PLEASE FILL OUT THIS SECTION AS WELL:

☐ I have read and understood the information provided on the consent form, and I agree that my daughter or son may participate in this study. I understand that their participation is voluntary, they may withdraw from participation at any time, and their academic standing will NOT be affected in any way by consenting or not consenting to participate in this study.

☐ I do not consent for my daughter or son to participate in the described study.

Parent's or legal guardian's name (print): _____
First name, Last name

Parent's or legal guardian's signature: _____ Date: _____
signature dd / mm / yyyy

Researcher's signature: _____ Date: _____
signature dd / mm / yyyy

Appendix B

Skill Evaluation Probing Rubric (Maxillary molar tooth)

Appendix B

Module 12: Basic Probe

		Pretest		Cognitive		Retention	
	Item Number	S	U	S	U	S	U
Positioning/Ergonomics	**Item Total:**						
Adjusts clinician chair correctly	1						
Reclines patient chair and assures that patient's head is even with top of headrest	2						
Positions instrument tray within easy reach for front, side, or rear delivery as appropriate for operatory configuration	3						
Positions unit light at arm's length or dons dental headlight and adjusts it for use	4						
Assumes the recommended clock position	5						
Positions backrest of patient chair for the specified arch and adjusts height of patient chair so that clinician's elbows remain at waist level when accessing the specified treatment area	6						
Asks patient to assume the head position that facilitates the clinician's view of the specified treatment area	7						
Maintains neutral position	8						
Directs light to illuminate the specified treatment area	9						
Instrument Grasp: Dominant Hand	**Item Total:**						
Grasps handle with tips of finger pads of index finger and thumb so that these fingers are opposite each other on the handle, but do NOT touch or overlap	10						
Rests pad of middle finger lightly on instrument shank; middle finger makes contact with ring finger	11						
Positions the thumb, index, and middle fingers in the "knuckles up" convex position; hyper-extended joint position is avoided	12						
Holds ring finger straight so that it supports the weight of hand and instrument; ring finger position is "advanced ahead of" the other fingers in the grasp	13						
Keeps index, middle, ring and little fingers in contact; "like fingers inside a mitten"	14						
Maintains a relaxed grasp; fingers are NOT blanched in grasp	15						
Finger Rest: Dominant Hand	**Item Total:**						
Establishes secure finger rest that is appropriate for tooth to be treated	16						
Once finger rest is established, pauses to self-evaluate finger placement in the grasp, verbalizes to evaluator his/her self-assessment of grasp, and corrects finger placement if necessary	17						
Insertion	**Item Total:**						
Establishes 0-degree angulation (face hugs tooth surface) in prepararion for insertion	18						
Gently inserts probe beneath the gingival margin to base of sulcus or pocket	19						
Probing Technique	**Item Total:**						
Orients probe working-end parallel to the root surface being probed	20						
Keeps tip in contact with the root surface	21						
Uses small walking strokes within the sulcus or periodontal pocket; maintains the probe beneath the gingival margin with each stroke	22						
Tilts probe and extends tip beneath contact area to assess interproximal area	23						
Covers entire circumference of the junctional epithelium with walking strokes	24						
Maintains neutral wrist position throughout motion activation	25						
Obtains measurement readings that are within 1 mm of the the evaluator's measurememts	26						
Total	**Item Total:**						

Rubric adapted from Nield-Gehrig, J. S. (2013). Fundamentals of Periodontal Instrumentation and Advanced Root Instrumentation. (8th Ed.). Toronto, ON: Lippincott Williams & Wilkins.

Appendix C

Qualitative survey questions

Appendix C

Confidential Demographic survey

Age			
Gender	female	male	
Years of education	High school ( )	College degree ( )	University degree ( )

Confidential Survey: 7 questions using a five-point Likert scale

Please circle your lab section: Thursday or Friday

I received feedback after every practice trial. ☐

I received feedback during 3 of the 6 practice trials ☐

Student perceptions regarding their experience	Strongly Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
I believe the feedback I received helped me improve my probing skills.	1	2	3	4	5
I would have preferred if the instructor gave me feedback while I was practicing my instrumentation skills and not at the end of the practice session.	1	2	3	4	5
I prefer to self-assess my probing skills prior to receiving instructor feedback. Receiving feedback once I finished worked well for me.	1	2	3	4	5
It is not necessary to observe my skills as I practice probing. The teacher is there to give me feedback.	1	2	3	4	5
I prefer to receive feedback from my instructor and do not see the necessity to assess my instrumentation skills	1	2	3	4	5
I believe I have the capabilities to correct my probing errors primarily on my own.	1	2	3	4	5

I now have a clear understanding of what I need to work on to improve my probing skills.	1	2	3	4	5

Four open-ended questions will examine themes and patterns and report on the findings.

1. Did you have a clear understanding of the probing criteria prior to the six practice trials? If so how did you prepare? If not what prevented you from understanding the probing criteria?

2. Was your instructor's feedback suitable for you to improve your probing skills by the end of the six probing trials? Explain your answer.

3. Did you assess your grasp force, hand movement and probe tip angulation as you practiced probing on your peer or did something prevent you from focusing on them? If so which ones did you rely on? If not, what prevented you from self-assessing your skills?

4. Do you believe you now have the ability to assess your probing skills effectively on your own? Explain your answer.

Appendix D

Probing Criteria for Posterior teeth (student handout)

Appendix D

Probing Criteria for Posterior teeth (student handout)

Demonstrates correct principles of positioning for the clinician.

Demonstrates correct principles of positioning for the client.

Demonstrates correct placement of the equipment (light).

Dental Mirror: Uses the mirror correctly for retraction and/ or indirect vision.

Light Modified Pen Grasp

Intraoral Fulcrum\Extraoral fulcrum: appropriate fulcrum

Probing Technique**:**

Appropriate force (pressure of the probe) during the walking stroke

Adapts tip (working end) at distal line angle and proceeds distally to distal contact

Tilts probe and extends tip beneath contact area to assess interproximal area

Readapts tip (working end) at the distal line angle and measures mesially to mesial contact

Tilts probe and extends tip beneath contact area to assess interproximal area

Uses small walking strokes within the sulcus to cover the circumference of each tooth

Positions probe parallel to the root surface

Notes:

_____

_____

_____

Appendix E

Permission to use the Periodontal Instrumentation course textbook's Probing Rubric from the author

Sent from my Samsung device

-------- Original message --------
From: "Erlichman, Caren"
Date: 05-04-2017 11:22 (GMT-05:00)
To: Bookpermissions , Debbie Desrivieres

Subject: RE: Permission to use online rubric

Hi Debbie.

Thanks for your patience. We will be able to grant your request to use the Basic Probe (excel Module 12-Probe) from Gehrig: Fundamentals of Periodontal Instrumentation and Advanced Root Instrumentation 8e (as you showed us in the document sent earlier, and approved by Jill Gehrig) in your thesis “The role of augmented feedback timing and frequency in the acquisition of fine motor instrumentation skills in dental hygiene” at John Abbott College.

If you are posting your thesis/dissertation online, the website on which you are posting must be password-protected. Posting of our content to commercial/social media websites, such as ProQuest, YouTube, ResearchGate, Facebook is strictly prohibited.

I am including a link (below) to our Terms and Conditions. Please consider those, and this email, your official grant of permission. Thank you.

www.lww.com/healthpermissions-terms

Sincerely,

Caren Erlichman

Caren Erlichman
Health Permissions Team
Health Learning, Research & Practice

Wolters Kluwer
Two Commerce Square

Appendix F

John Abbott College's Ethics Clearance Certificate

Appendix F

JOHN ABBOTT
CEGEP/COLLEGE

Certificate of Ethics Approval

Date:	June 13, 2017		
School /Academic unit: Title of project:	CEGEP John Abbott College, Dept Nursing		
	The role of augmented feedback frequency in the acquisition of fine motor instrumentation skills in dental hygiene.		
Names & Titles of project research team members:	Researchers : Debbie Desrivieres, CEGEP John Abbott College		
Affiliation Email address:	x **JAC researcher** x **MTP Research** … **EXTernal research**		
Phone:			
	(Home)	(Cell)	(Work)

The members of the John Abbott College Research Ethics Board have examined the application and consider the experimental procedures as outlined by the applicant to be on acceptable on ethical grounds for research involving human participants. A final report summarizing the findings should be submitted to John Abbott College within six months of the completion of the study.

This project has been approved for the period of : 1 year	From:	08-13-2017	To:	07-12-2018
		dd – mm - yyyy		dd – mm - yyyy
Certificate number:	JACREB201702	This approval of research ethics does not guarantee that CEGEP John Abbott College will provide access to any institutional services, such as Data Mining.		
Co-Chairs of REB of CEGEP John Abbott College	Laura Shillington and Shireef Darwish			

Signature:		Date: 08-13-2017 dd – mm - yyyy